Claims

1. A magnetic field sensor device comprising an oscillatory member and current control means, wherein the current control means is arranged to pass an alternating current (AC) along at least first and second current paths provided through the oscillatory member, characterised in that the current control means is arranged to provide magnetic gradiometer mode operation in which current flow through the first current path is in substantially the opposite direction to current flow through the second current path.

2. A device according to claim 1 wherein the current control means is arranged to additionally provide magnetometer mode operation in which current flow through the first current path is in substantially the same direction as current flow through the second current path.

3. A device according to claim 1 wherein the current control means is arranged to additionally provide magnetometer mode operation in which AC is passed through only the first current path.

4. A device according to any one of claims 2 to 3 wherein the current control means comprises a mode selector for switching to either one of gradiometer mode and magnetometer mode as required.

5. A device according to any one of the preceding claims and further comprising sensing means for providing an output signal dependent on the deflection of the oscillatory member.

6. A device according claim 5 wherein the sensing means comprises at least one sensor electrode located on the substrate and having a variable capacitance with the oscillatory member.

7. A device according to claim 6 wherein the sensing means comprises a plurality of elongate sensor electrodes located on the substrate and the oscillatory member comprises a plurality of elongate electrodes interdigitated with said plurality of elongate sensor electrodes.

8. A device according to claim 7 wherein the electrodes of the oscillatory member are maintained at a predetermined direct current (DC) polarisation voltage.

9. A device according to claim 7 wherein a high frequency AC polarisation voltage is applied to the electrodes of the oscillatory member.

10. A device according to any one of claims 7 to 9 wherein said plurality of sensor electrodes are electrically connected to form two electrode sets, the two electrode sets being arranged to provide differential capacitive pick-off.

11. A device according to any one of the preceding claims wherein driving means are additionally provided to impart a magnetic field independent oscillatory force to the oscillatory member.

12. A device according to claim 11 wherein the oscillatory member is carried on a substrate and the driving means comprises at least one drive electrode formed on the substrate to electrostatically impart the oscillatory force to the oscillatory member.

13. A magnetometer according to claim 12 in which the driving means comprises a plurality of first elongate drive electrodes formed on the substrate and the oscillatory member comprises a plurality of second elongate drive electrodes, wherein the first elongate drive electrodes are interdigitated with the second elongate drive electrodes.

14. A device according to any one of claims 11 to 13 when dependent on claim 5 wherein the driving means comprises a positive feedback circuit for receiving the output signal produced by the sensing means.

15. A device according to claim 14 wherein the driving means provides an oscillatory force of fixed amplitude.

16. A device according to claim 14 in which the driving means is arranged to impart an oscillatory force to the oscillatory member of adjustable amplitude, wherein the amplitude of the oscillatory force applied by the driving means is adjusted during use so as to maintain a given amplitude of oscillation of the oscillatory member.

17. A device according to any one of the preceding claims wherein the frequency of the AC passed through the oscillatory member by the current control means is substantially equal to the resonant frequency of the oscillatory member.

18. A device according to any one of the preceding claims wherein the current control means comprises a voltage source for supplying the AC passed through the oscillatory member.

19. A device according to claim 18 when dependent on claim 5 wherein the current control means comprises a feedback circuit arranged to receive the output signal produced by the sensing means.

20. A device according to any one of the preceding claims wherein the first and second current paths of the oscillatory member comprise substantially straight conductive tracks.

21. A device according to claim 20 wherein the conductive track forming the first current path is substantially parallel to the conductive path forming the second current path

22. A device according to any one of the preceding claims wherein the length of the first current path through the oscillatory member is substantially equal to the length of the second current path through the oscillatory member.

23. A device according to any one of the preceding claims wherein the first current path through the oscillatory member is spatially separated from the second current path through the oscillatory member by more than 5mm.

24. A device according to any one of the preceding claims wherein the oscillatory member comprises at least first and second flexible leg portions, the first leg portion comprising a conductive portion defining the first current path and the second leg portion comprising a conductive portion defining the second current path.

25. A device according to claim 24 wherein the oscillatory member comprises a substantially rigid cross-beam, a first end of the crossbeam being attached to the first flexible leg portion and the second end of the crossbeam being attached to the second flexible leg portion.

26. A device according to claim 25 wherein one or more additional flexible leg portions are attached to the crossbeam.

27. A device according to any one of claims 25 to 26 wherein one or more elongate electrodes protrude from the cross-beam.

28. A device according to any one of claims 25 to 27 wherein the cross beam is maintained at a given polarisation voltage during use.

29. A device according to any one of the preceding claims wherein the oscillatory member comprises at least one stress relief means.

30. A device according to claim 29 wherein the at least one stress relief means comprises a stress relief loop.

31. A device according to any one of the preceding claims formed as a micro-electromechanical system (MEMS).

32. A device according to any one of the preceding claims wherein the oscillatory member is suspended on a substrate.

33. A device according to claim 32 wherein the oscillatory member is arranged to oscillate along an axis in a plane substantially parallel to the plane of the substrate.

34. A device according to any one of claims 32 to 33 wherein the substrate and oscillatory member are formed from any one of a silicon-on-insulator (SOI) wafer and a silicon-on-glass (SOG) wafer.

35. A compass comprising at least one magnetic field sensor device according to any one of the preceding claims.

36. A compass comprising at least one magnetic field sensor device according to any one of claim 4 and claims 5 to 34 when dependent directly or indirectly on claim 4.

37. A compass according to claim 36 comprising three magnetic field sensing devices, each of the three magnetic field sensing devices being arranged to acquire magnetic field measurements along mutually orthogonal axes.

38. A compass according to claim 37 and further comprising a processing means, the processing means being arranged to switch each magnetic field sensor device between magnetometer mode and gradiometer mode as required and to determine therefrom a compass bearing that is corrected for any localised magnetic field anomalies.

39. An inertial measurement unit comprising a compass according to any one of claims 35 to 38.

40. A compass comprising means for measuring magnetic field strength characterised in that the compass additionally comprises means for measuring magnetic field gradient.

41. A compass according to claim 40 and further comprising a processor, the processor being arranged to take magnetic field strength and magnetic field gradient measurements and provide compass bearings corrected for localised magnetic field anomalies.

42. A method of operating a magnetic field sensor device comprising the steps of taking a magnetic field sensor device comprising an oscillatory member and passing an alternating current (AC) through the oscillatory member, characterised in that the oscillatory member comprises at least first and second current paths and in that, during use, an AC is passed along the at least first and second current paths.

43. A method according to claim 42 wherein AC is passed along the first current path in a substantially opposite direction to the second current path.